Typical

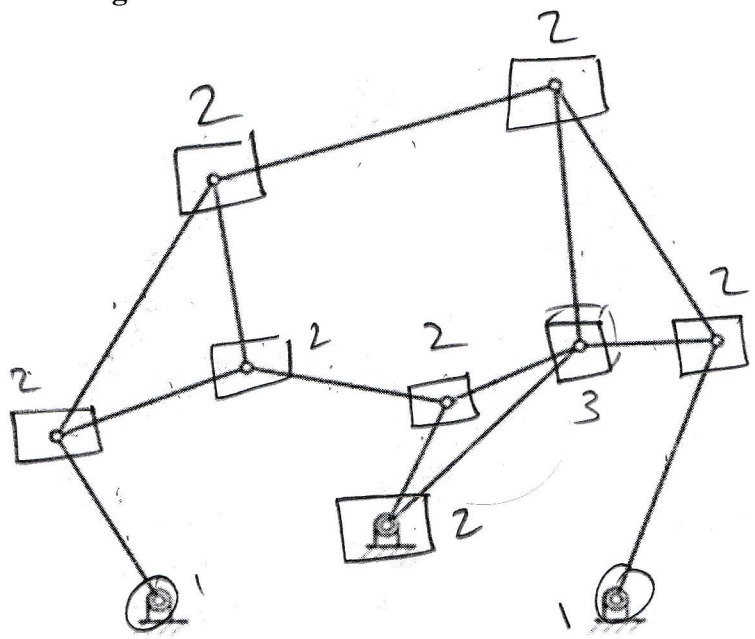
Faculty of Engineering | **Philadelphia University** | Mechanical Eng. Dep.

Theory of machines | **section #2** | **Allowed time: 10 min**

Eng. Laith R. Batarseh | **First Quiz** | **Monday 30/10/2017**

Student Name: **Student ID number:**

Problem: Determine the mobility for the following mechanism



$N = 14$

$P_1 = 19$

$P_2 = 0$

$M = 3(N-1) - 2P_1 - P_2 = 3(14-1) - (2)(19) - 0$

$\Rightarrow M = 1$

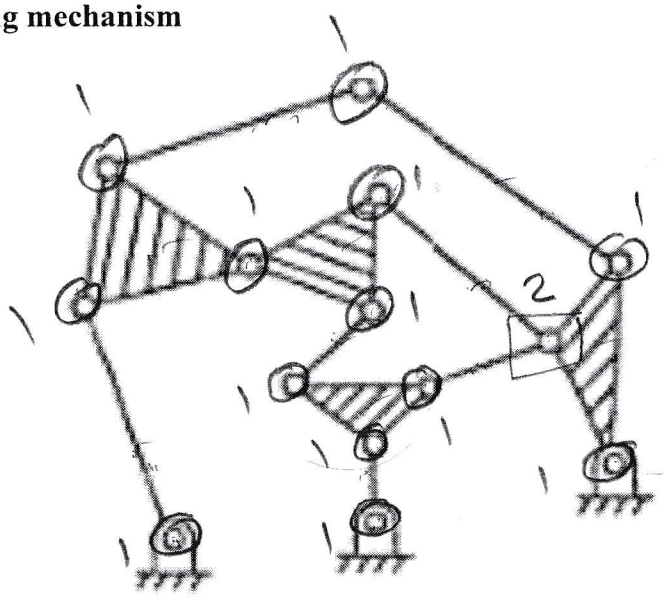
Faculty of Engineering | **Philadelphia University** | Mechanical Eng. Dep.

Theory of machines | **section #1** | **Allowed time: 10 min**

Eng. Laith R. Batarseh | **First Quiz** | **Sunday 29/10/2017**

Student Name: **Student ID number:**

Problem: Determine the mobility for the following mechanism



$n = 12$

$p_1 = 15$

$p_2 = 0$

$M = 3(n-1) - 2p_1 - p_2$

$\Rightarrow M = 3(12-1) - (2)(15) - 0 = \boxed{3}$

Faculty of Engineering | **Philadelphia University** | Mechanical Eng. Dep.

Theory of machines | **section #1** | **Allowed time: 10 min**

Eng. Laith R. Batarseh | **First Quiz** | **Sunday 29/10/2017**

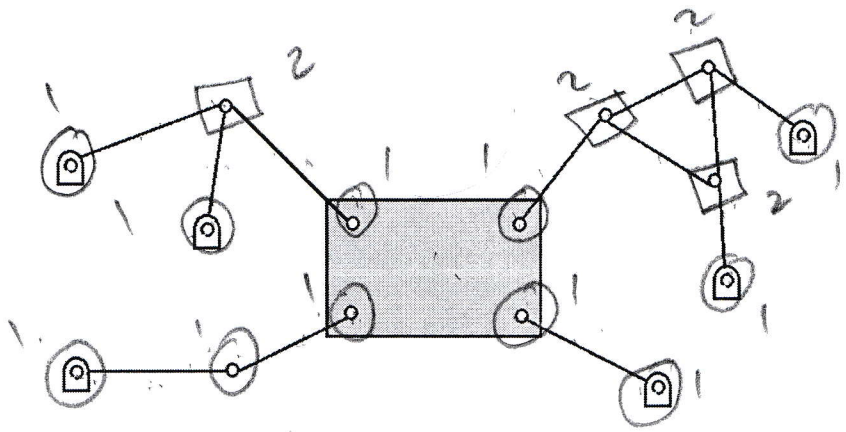
Student Name: **Student ID number:**

Problem: Determine the mobility for the following mechanism

$n = 14$

$P_1 = 19$

$P_2 = 0$



$$M = 3(n-1) - 2P_1 - P_2 = 3(14-1) - (2)(19) - 0 = 1$$

Faculty of Engineering	**Philadelphia University**	Mechanical Eng. Dep.
Theory of machines	**section #2**	**Allowed time: 10 min**
Eng. Laith R. Batarseh	**second quiz** Typical	**Monday 4/12/2017**

Student Name: **Student ID number:**

Consider the following loop closer equation for a four bar mechanism:

$$d_2U_{\theta 2} + d_3U_{\theta 3} - d_1U_{\theta 1} = d_4U_{\theta 4}.$$

Assume link (1) $d_1U_{\theta 1}$ is ground. Find ω_3 and ω_4 if

$\theta_1 = 0$	$\theta_2 = 60$ degree	$\theta_3 = 30$ degree	$\theta_4 = 90$ degree	$\omega_2 = 600$ RPM

$d_1 = 1.2m$ $d_2 = 0.2\ m$ $d_3 = 0.8\ m$ $d_4 = 0.4m$

Sol:-

$$\frac{d}{dt}\left[d_2U_{\theta 2} + d_3U_{\theta 3} - d_1U_{\theta 1} = d_4U_{\theta 4}\right)$$

$$d_2\omega_2 iU_{\theta 2} + d_3\omega_3 iU_{\theta 3} - 0 = d_4\omega_4 iU_{\theta 4} \quad \text{— (1)}$$

To eleminate ω_4, dot Eq (1) with $U_{\theta 4}$:

$$d_2\omega_2 \sin(\theta_4 - \theta_2) + d_3\omega_3 \sin(\theta_4 - \theta_3) = 0$$

$$\Rightarrow \omega_3 = -\frac{d_2\omega_2 \sin(\theta_4 - \theta_2)}{d_3 \sin(\theta_4 - \theta_2)} = -\frac{(0.2)(600)\sin(90-60)}{0.8\ \sin(90-30)}$$

$$\Rightarrow \omega_3 = -86.6\ \text{RPM}$$

to Find ω_4 dot Eq 1 By $U_{\theta 3}$

$$d_2\omega_2 \sin(\theta_3 - \theta_2) + 0 = d_4\omega_4 \sin(\theta_3 - \theta_4)$$

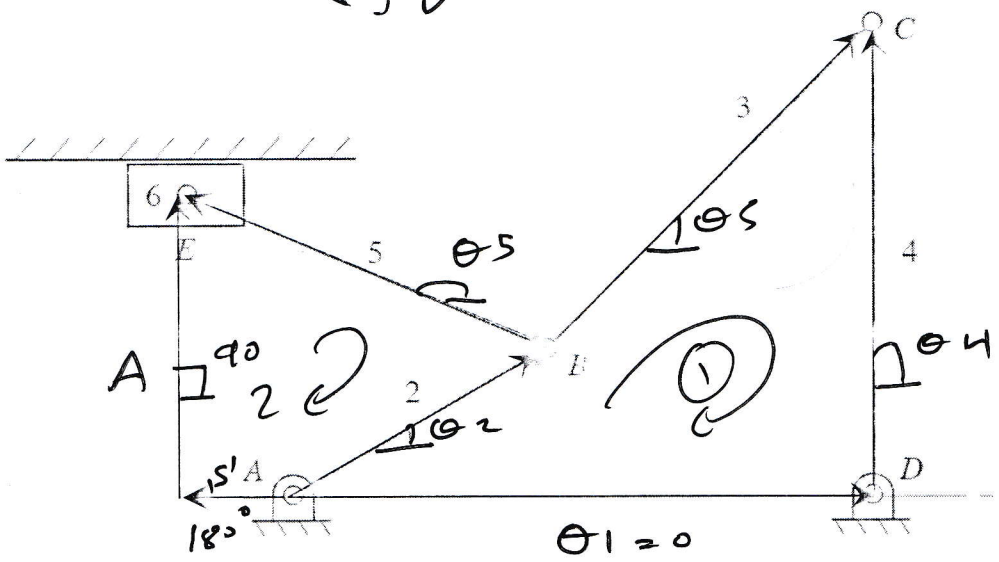
$$\omega_4 = \frac{d_2\omega_2 \sin(\theta_3 - \theta_2)}{d_4 \sin(\theta_3 - \theta_4)} = \frac{0.2\,(600)\sin(30-60}{0.4\ \sin(30-90)} = 173.2\ \text{RPM}$$

Faculty of Engineering	Philadelphia University	Mechanical Eng. Dep.
Theory of machines	section #1	Allowed time: 10 min
Eng. Laith R. Batarseh	second quiz	Sunday 3/12/2017

Student Name: Student ID number:

Problem: derive the acceleration loop equation for the following mechanism

Typical



Loop 1:-

$$d_1 \angle\theta_1 + d_4 \angle\theta_4 = d_2 \angle\theta_2 + d_3 \angle\theta_3 \quad --(1)$$

$$d_2 \angle\theta_2 + d_5 \angle\theta_5 = 5 \angle 180 + A \angle 90 \quad --(2)$$

$\frac{d}{dt}$ (Eq1) & (Eq2):

$$0 + d_4 [\alpha_4 \angle\theta_4 - \omega_4^2 \angle\theta_4] = d_2 [\alpha_2 \angle\theta_2 - \omega_2^2 \angle\theta_2] + d_3 [\alpha_3 \angle\theta_3 - \omega_3^2 \angle\theta_3] \quad --(3)$$

$$d_2 [\alpha_2 \angle\theta_2 - \omega_2^2 \angle\theta_2] + d_5 [\alpha_5 \angle\theta_5 - \omega_5^2 \angle\theta_5] = 5 \angle 180 \quad --(4)$$

Eqs (3) & (4) are the loop closure Eqs for acc.

Faculty of Engineering	**Philadelphia University**	Mechanical Eng. Dep.
Theory of machines	**section #2**	**Allowed time: 10 min**
Eng. Laith R. Batarseh	**third quiz**	**Wednesday 3/1/2018**

Student Name: **Student ID number:**

typical

Problem: a cam segment has the following specifications

- Rise from 0 to 3 cm for a period from 0 to 120° degree
- The rise is a parabolic

Find the follower travel at θ =80°

Because $\beta = 120^\circ$ & $\theta = 80^\circ$

$$S = H\left[1-2\left[1-\frac{\theta}{\beta}\right]^2\right]$$

$$S = 3\left[1-2\left[1-\frac{80}{120}\right]^2\right]$$

$$= 2.33 \text{ cm}$$

$$S = 2H\left(\frac{\theta}{\beta}\right)^2 ; S = H\left[1-2\left(1-\frac{\theta}{\beta}\right)^2\right]$$

$$s(\theta) = \frac{H}{2}\left(1-\cos\left(\frac{\pi\theta}{\beta}\right)\right)$$

$$s(\theta) = \frac{h}{\pi}\left(\frac{\pi\theta}{\beta}-\frac{1}{2}\sin\left(\frac{2\pi\theta}{\beta}\right)\right)$$

F .culty of Engineering | **Philadelphia University** | Mechanical Eng. Dep.

Theory of machines | **section #1** | **Allowed time: 10 min**

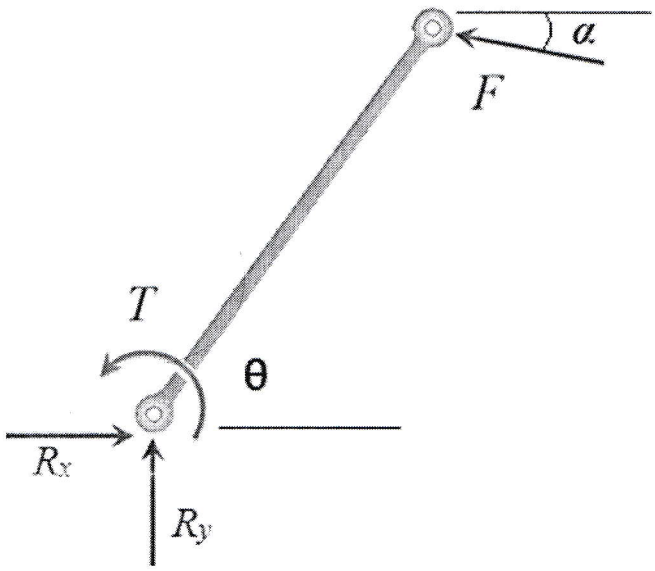
Eng. Laith R. Batarseh | **third quiz** | **Sunday 24/12/2017**

~~Typical~~

Student Name: **Student ID number:**

Problem: consider the following bar link. If its length is 40cm, θ = 60 degree, α = 30 degree and T = 50 N.M.

Find the reactions R_x, R_y and F.



(1) $\xrightarrow{+}\Sigma F_x = 0$

$\Rightarrow R_x - F\cos\alpha = 0$

$\Rightarrow R_x - F\cos 30 = 0$ --(1)

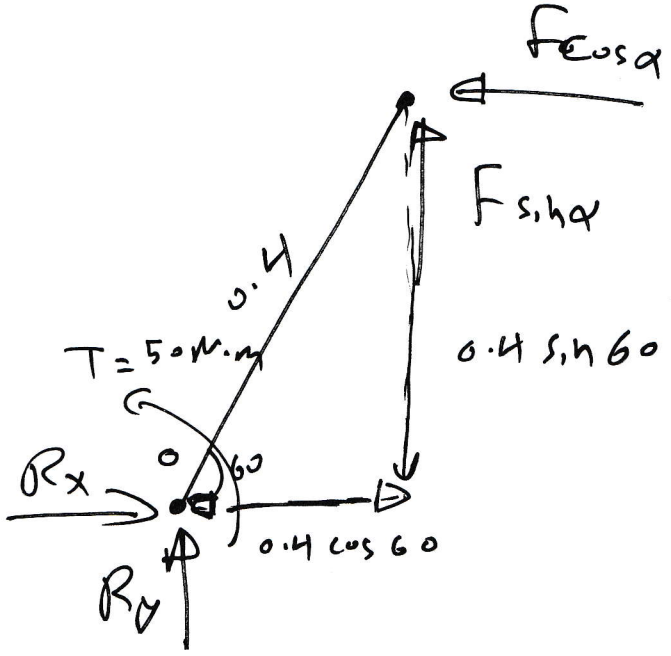
(2) $\uparrow+\Sigma F_y = 0$

$\Rightarrow R_y + F\sin\alpha = 0$

$\Rightarrow R_y + F\sin 30 = 0$

(3) $\circlearrowleft+\Sigma M_o = 0$

$T + F\cos\alpha\,(0.4\sin 60) + F\sin\alpha\,(0.4\cos 60) = 0$



$\Rightarrow 50 + F[0.3 + 0.1] = 0 \Rightarrow F = -125\,N$

$R_x = -108.3\,N$

$R_y = 62.5\,N$

Faculty of Engineering	**Philadelphia University**	Mechanical Eng. Dep.
Course name: Theory of machines	**4th and 5th Quiz**	Course number:620333 class(1)
Instructor: Eng. Laith Batarseh	**Thursday 9/1/2018**	Allowed time: 20 minutes

Student Name: **Student ID number:**

Problem 1: a cam segment has the following specifications

- Rise from 0 to 5cm for a period from 0 to 90° degree
- The rise is a parabolic

Find the follower travel at θ =40°

$\beta = 90 \qquad \beta/2 = 45$

So θ lies in the period

$0 \le \theta \le \frac{\beta}{2}$

$S = 2H\left(\frac{\theta}{\beta}\right)^2 ; S = H\left(1-2\left(1-\frac{\theta}{\beta}\right)^2\right)$

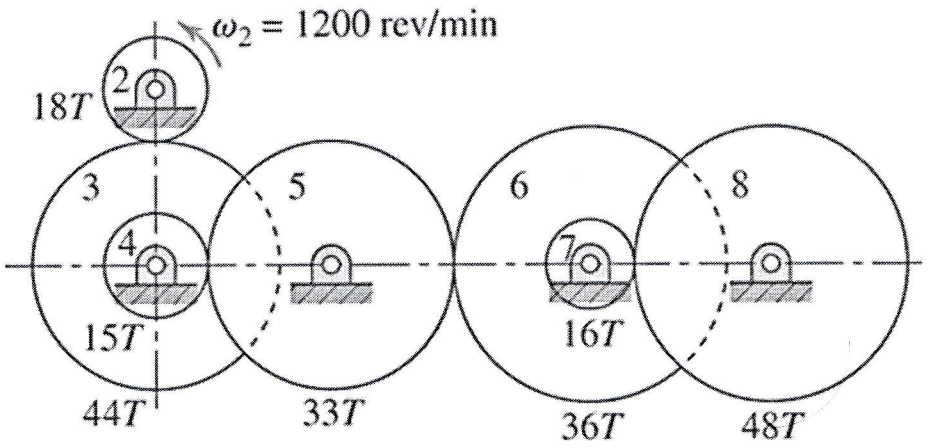
$s(\theta) = \frac{H}{2}\left(1-\cos\left(\frac{\pi\theta}{\beta}\right)\right)$

$s(\theta) = \frac{h}{\pi}\left(\frac{\pi\theta}{\beta}-\frac{1}{2}\sin\left(\frac{2\pi\theta}{\beta}\right)\right)$

$S = 2H\left(\frac{\theta}{\beta}\right)^2$

$= (2)(5)\left(\frac{40}{90}\right)^2 = 1.97 \text{ cm}$

Problem 2: For the following **compound** gear train, find ω_8. **T** stand for teeth



$$\frac{\omega_8}{\omega_2} = \left[-\frac{\omega_3}{\omega_2}\right]\left[\frac{\omega_4}{\omega_3}\right]\left[-\frac{\omega_5}{\omega_4}\right]\left[-\frac{\omega_6}{\omega_5}\right]\left[\frac{\omega_7}{\omega_6}\right]\left[-\frac{\omega_8}{\omega_7}\right]$$

$$= +\frac{\omega_3\,\omega_5\,\omega_6\,\omega_8}{\omega_2\,\omega_4\,\omega_5\,\omega_7}$$

$$= \frac{N_2\,N_4\,N_7}{N_3\,N_6\,N_8} = \frac{(18)(15)(16)}{(44)(36)(48)}$$

$$\frac{\omega_8}{\omega_2} = \frac{5}{88} \rightarrow \omega_8 = 1200\left(\frac{5}{88}\right) = 68.2\ \text{RPM}$$

Faculty of Engineering	**Philadelphia University**	Mechanical Eng. Dep.
Course name: Theory of machines	**4th and 5th Quiz**	Course number:620333 class(2)
Instructor: Eng. Laith Batarseh	**Monday 15/1/2018**	Allowed time: 20 minutes

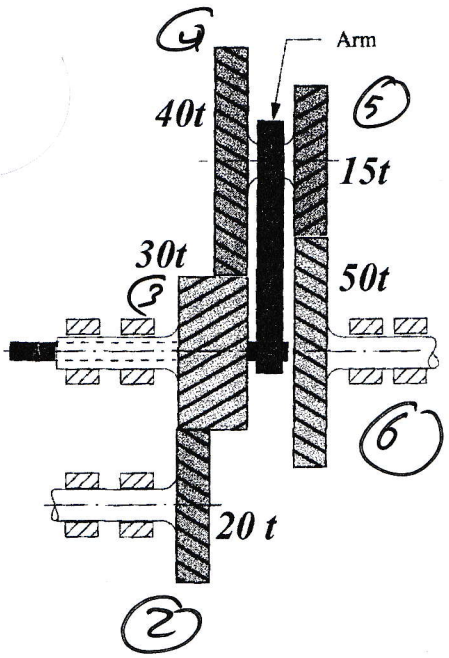
Student Name: **Student ID number:**

Problem 1: if ω2 = 400 RPM and ω_{arm} = -100 for the gear train. Find the speed of gear 6.

$$\frac{w_6 - w_a}{w_2 - w_a} = \left[-\frac{w_3}{w_2}\right]\left[-\frac{w_4}{w_3}\right]\left[\frac{w_5}{w_4}\right]\left[-\frac{w_6}{w_5}\right] \quad (1)$$

$$\Rightarrow \frac{w_6 + 100}{400 + 100} = -\frac{w_4\ w_6}{w_2\ w_5}$$

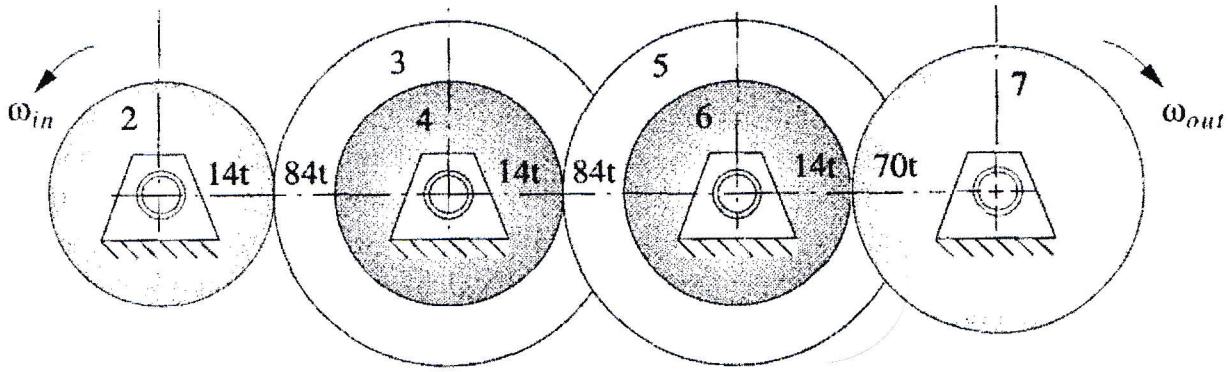
$$\Rightarrow \frac{w_6 + 100}{500} = -\frac{N_2\ N_5}{N_4\ N_6}$$



$$w_6 = -500\left[\frac{(20)(15)}{(40)(50)}\right] - 100$$

$$w_6 = -175\ RPm = 175\ RPm \circlearrowleft$$

Problem 2: consider the following **compound** gear train, if $\omega_2 = 600$ RPM, find ω_7. **t** stand for teeth



$$\frac{\omega_7}{\omega_2} = \left[-\frac{N_3}{N_2}\right]\left[\frac{N_4}{N_3}\right]\left[-\frac{N_5}{N_4}\right]\left[\frac{N_6}{N_5}\right]\left[-\frac{N_7}{N_6}\right]$$

$$\frac{\omega_7}{\omega_2} = -\frac{N_3\, N_5\, N_7}{N_2\, N_4\, N_6} = -\frac{N_2\, N_4\, N_6}{N_3\, N_5\, N_7}$$

$$\omega_7 = \omega_2 \frac{N_2\, N_4\, N_6}{N_3\, N_5\, N_7} = -600\left[\frac{(14)(14)(14)}{(84)(84)(70)}\right]$$

$$\omega_7 = -3.33 \text{ RPM}.$$